

# The Nuclear Physics SBIR/STTR Program :

DOE/NSF NSAC Meeting

October 28, 2016  
Gaithersburg, MD

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and

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# Outline

- SBIR/STTR – Background
- The DOE-NP SBIR/STTR Program
  - NP SBIR Topics
  - NP SBIR/STTR Applications and Grants (through FY 2016)
- Noteworthy products that came to fruition funded, at least partly, due to the NP SBIR/STTR Program
- The DOE SBIR/STTR Program in FY2017
  - New commercialization and outreach efforts
- Conclusions



# SBIR/STTR Program History and Goals

## **Small Business Innovation Research (SBIR) *est. 1982***

- Stimulate technological innovation
- Use small business to meet Federal R&D needs
- Foster and encourage participation by women and socially and economically disadvantaged persons in technological innovation
- Increase private-sector commercialization of innovations derived from Federal R&D

## **Small Business Technology Transfer (STTR) *est. 1992***

- Stimulate and foster scientific and technological innovation through cooperative research and development carried out between small business concerns and research institutions
- Foster technology transfer between small business concerns and research institutions

*SBIR and STTR were reauthorized on December 31, 2011 (P.L. 112-81) through September 30, 2017*

# The Three SBIR/STTR Phases

## PHASE I: FEASIBILITY, PROOF OF CONCEPT

- Award Amount: \$150,000 (guideline), \$225,000 (max.)
- Project Duration: 6-12 months



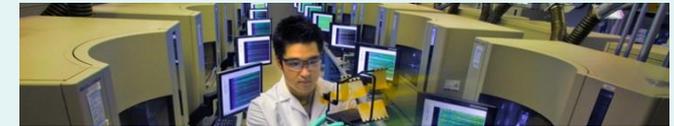
## PHASE II: CONTINUE R/R&D FOR PROTOTYPES OR PROCESSES

- Award Amount: \$1,000,000 (guideline), \$1,500,000 (max.)
- Project Duration: 2 years



## PHASE III: COMMERCIALIZATION

- Federal or Private Funding (non-SBIR/STTR funds)
- No dollar or time limits

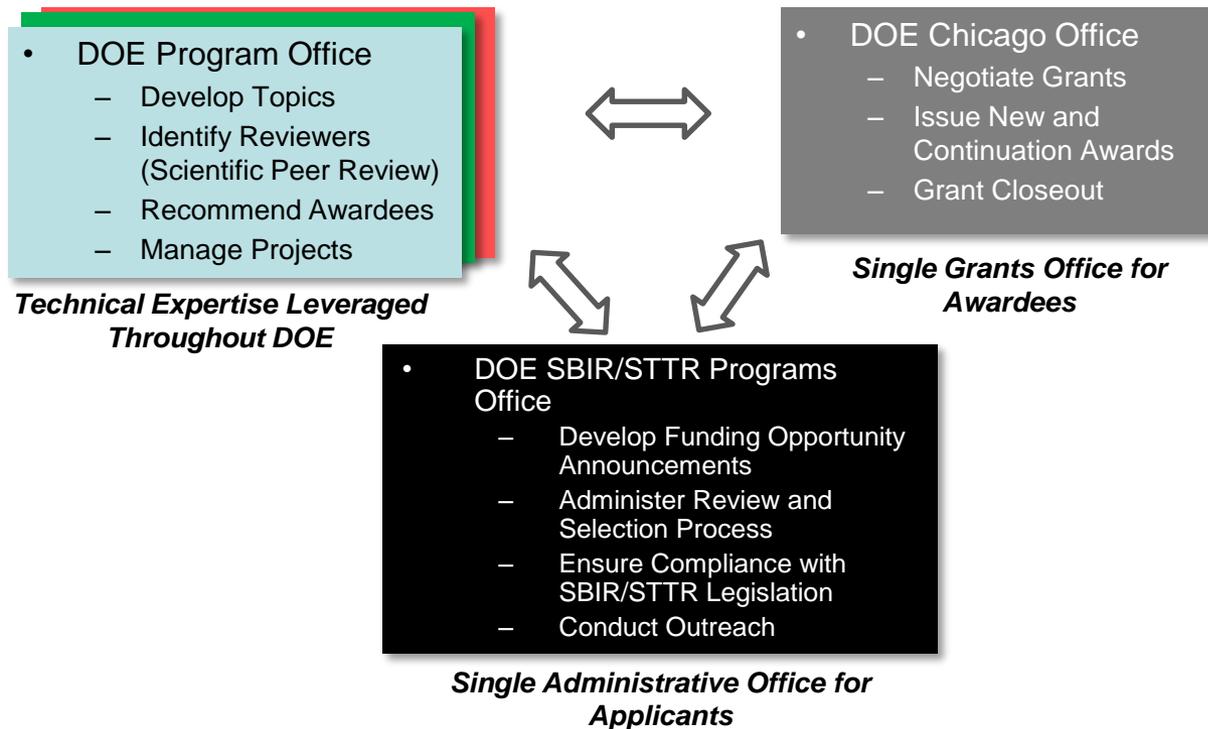


Not implemented by DOE, instead -

## SEQUENTIAL PHASE IIA OR IIB: CONTINUE R/R&D FOR PROTOTYPES OR PROCESSES

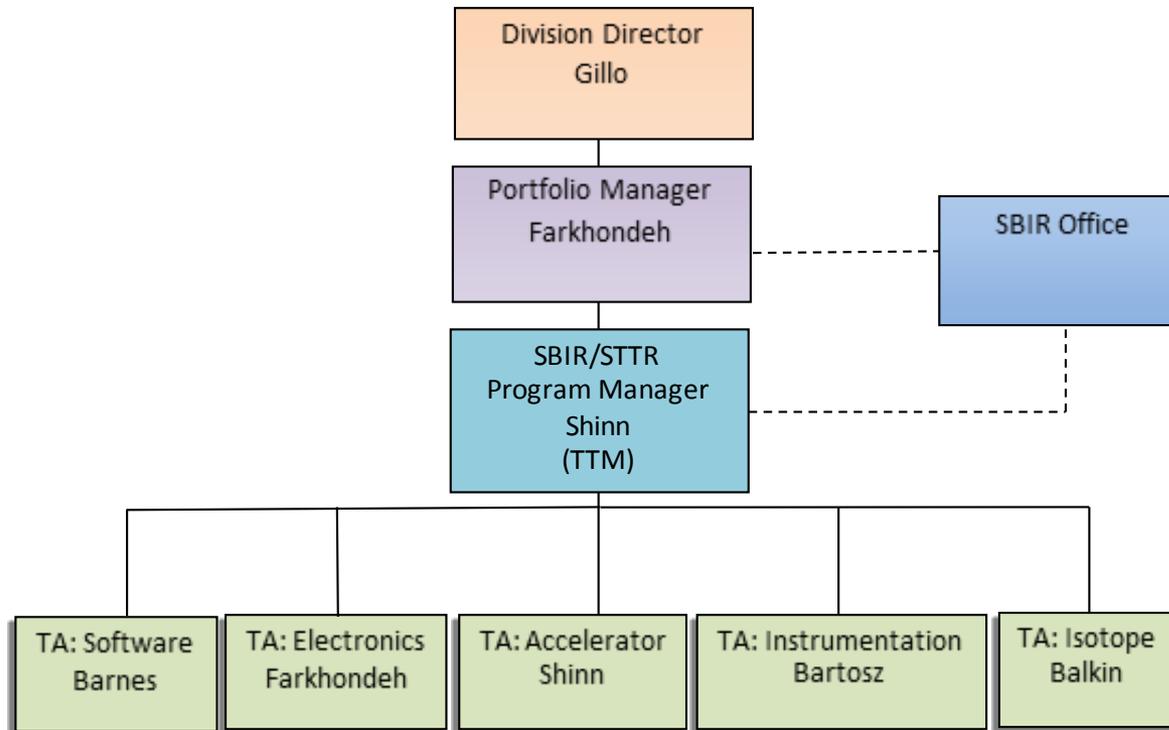
- **PHASE IIA:** FOR CERTAIN PROTOTYPES, PRODUCTS, OR PROCESSES THAT NEED MORE DEVELOPMENT
- **PHASE IIB:** FOR R&D FUNDING REQUIRED TO TRANSITION AN INNOVATION TOWARDS COMMERCIALIZATION.
- Award Amount: \$1,000,000
- Project Duration: 2 years

# Operation of the DOE SBIR and STTR Programs



- NP determines what R&D gets funded, but is otherwise freed of much of the administration of those funds.

### NP SBIR/STTR Org. Chart: (10/27/2016)



**Technical Topic Manager (TTM)**

**Activities**

- Communicate w/ SBIR Office
- Prepare annual solicitation
- Chair 1<sup>st</sup> step panel review
- Rank proposals
- Recommend funding
- Visit companies
- Read progress and final reports
- 2<sup>nd</sup> year continuation

**Topic Associate (TA)**

**Activities for Assigned Topics**

- Provide input to annual solicitation
- \*Assign reviewers
- \*Assess proposals
- Manage assigned grants
- Read reports assigned

\*Time Sensitive tasks

For the last 10 years, Manouchehr has ably managed this program

I became the SBIR Program Manager in January 2016



# Phase I Funding Opportunity Announcements Participating DOE Programs (FY 2017)

## Phase I Release 1

- Office of Advanced Scientific Computing Research (ASCR)
- Office of Basic Energy Sciences (BES)
- Office of Biological and Environmental Research (BER)
- **Office of Nuclear Physics (NP)**

## Phase I Release 2

- Office of Defense Nuclear Nonproliferation (NA)
- Office of Electricity Delivery and Energy Reliability (OE)
- Office of Energy Efficiency and Renewable Energy (EERE)
- Office of Fossil Energy (FE)
- Office of Fusion Energy Sciences (FES)
- Office of High Energy Physics (HEP)
- Office of Nuclear Energy (NE)

# Annual SBIR/STTR funding percentages FY15 and out-years

- In FY2015, all Federal agencies with an extramural research budget greater than \$100M contributed 2.9% of that budget to the SBIR portion of the program.
- If the agency has greater than \$1B in extramural R/R&D, then 0.4% of that budget went to the STTR program.
- These values have risen steadily since the 2011 reauthorization.

<b>%</b>	FY15	FY16	FY17	FY18	FY19	FY20	FY21
SBIR	2.9	3.0	3.2	3.2	3.2	3.2	3.2
STTR	0.40	0.45	0.45	0.45	0.45	0.45	0.45
Total	3.30	3.45	3.65	3.65	3.65	3.65	3.65

- The SBIR/STTR program is due for reauthorization at the end of this fiscal year, so values in blue are conjectural.



## How are the funding levels determined for NP?

- Extramural research is the NP budget minus the following:
  - Construction
  - Isotope Program Facility Operations
  - General Plant Projects, Accelerator Improvement Projects, and Capital Equipment
- The Budget Office separately confirms the base amount that is to be set aside, based on the enacted appropriation and the Annual Financial Plan (AFP).
- Funds are usually transferred by January to the SBIR/STTR Program.
- The SBIR/STTR Office uses ~ 1-2% of this amount for administration and capital assistance funds.
- The remainder of the funding is distributed to maximize the number of SBIR and STTR awards within the defined award amounts.
  - Phase I awards are \$150k for 9 months.
  - Phase II awards are \$1M for 2 years.

## NP Funding – historical and out-year projections

<b>K\$</b>	FY15	FY16	FY17	FY18	FY19	FY20	FY21
SBIR	12,967	14,040	15,250	15,875	16,975	18,369	19,918
STTR	1,789	2,106	2,145	2,237	2,376	2,580	2,712
<b>Total</b>	<b>14,756</b>	<b>16,146</b>	<b>17,395</b>	<b>18,112</b>	<b>19,321</b>	<b>20,949</b>	<b>22,630</b>

Projection based on FY17 Initial AFP

- Total value of grants funded FY 2014 - 2016: \$44.45M
- 59 companies funded during this time span!



# NP yearly SBIR/STTR topic development process

- Start with last year's published topic document and make initial revisions based on a year-round observation of needs by Program Managers and NP community input as well as,
- Request input for each topic from subject matter experts within the NP community,
- Collect and implement all inputs on existing subtopics. Add and/or delete subtopics as necessary,
- Review HEP and BES Topics to insure we don't unnecessarily duplicate-fund companies,
- Submit the revised topics to the DOE SBIR/STTR office and,
- After further formatting iterations with the SBIR/STTR office, the topics are published in mid-July
- The solicitation is published as a Funding Opportunity Announcement (FOA) around the middle of August
- Letters of Intent to submit a proposal are due the day after Labor Day
- Proposals are due around the middle of October



## NP SBIR/STTR Topics for FY 2017

- Software and Data Management
  - Electronics Design and Fabrication
  - Accelerator Technology
  - Instrumentation, Detection Systems and Techniques
  - Isotope Science and Technology
- 
- Considerable Revisions of subtopics this year in various topics.
  - The subtopics are chosen to advance NP core technologies, e.g., polarized electrons, as well as provide for R&D leading to hardware used in MIEs.
  - Funding Note: There is no fixed set aside for each topic. Proposals from all 5 topics compete with each other and highly ranked applications are funded.



## NP Topic 1 Software and Data Management

- a. Large Scale Data Storage
- b. Software-driven Network Architectures for Data Acquisition
- c. Data Science/Distributed Computing Applications
- d. Heterogeneous Concurrent Computing
- e. Other

Topic Associate – Ted Barnes

## NP Topic 2 Electronics Design and Fabrication

- a. Advances in Digital Processing Electronics
- b. Front-End Application-Specific Integrated Circuits
- c. Advanced Devices and Systems
- d. Next Generation Pixel Sensors
- e. Manufacturing and Advanced Interconnection Techniques
- f. Other

Topic Associate – Manouchehr Farkhondeh



## NP Topic 3 Accelerator Technology

- a. Materials and Components for Radio Frequency Devices
- b. Radio Frequency Power Sources
- c. Design and Operation of Radio Frequency Beam Acceleration Systems
- d. Particle Beam Sources and Techniques
- e. Polarized Beam Sources and Polarimeters
- f. Rare Isotope Beam Production Technology
- g. Accelerator Control and Diagnostics
- h. Magnet Development for Proposed Future Electron-Ion Colliders (EIC)
- i. Accelerator Systems Associated with the Capability to Deliver Heavy-Ion Beams to Multiple Users
- j. Other

Topic Associate – Michelle Shinn



## NP Topic 4 Instrum. Detection Sys. and Techniques

- a. Advances in Detector and Spectrometer Technology
- b. Development of Novel Gas and Solid-State Detectors
- c. Technology for Rare Decay and Rare Particle Detection
- d. High Performance Scintillators, Cherenkov Materials and Other Optical Components
- e. Specialized Targets for Nuclear Physics Research
- f. Technology for High Radiation environments
- g. Other

Topic Associate – Elizabeth Bartosz

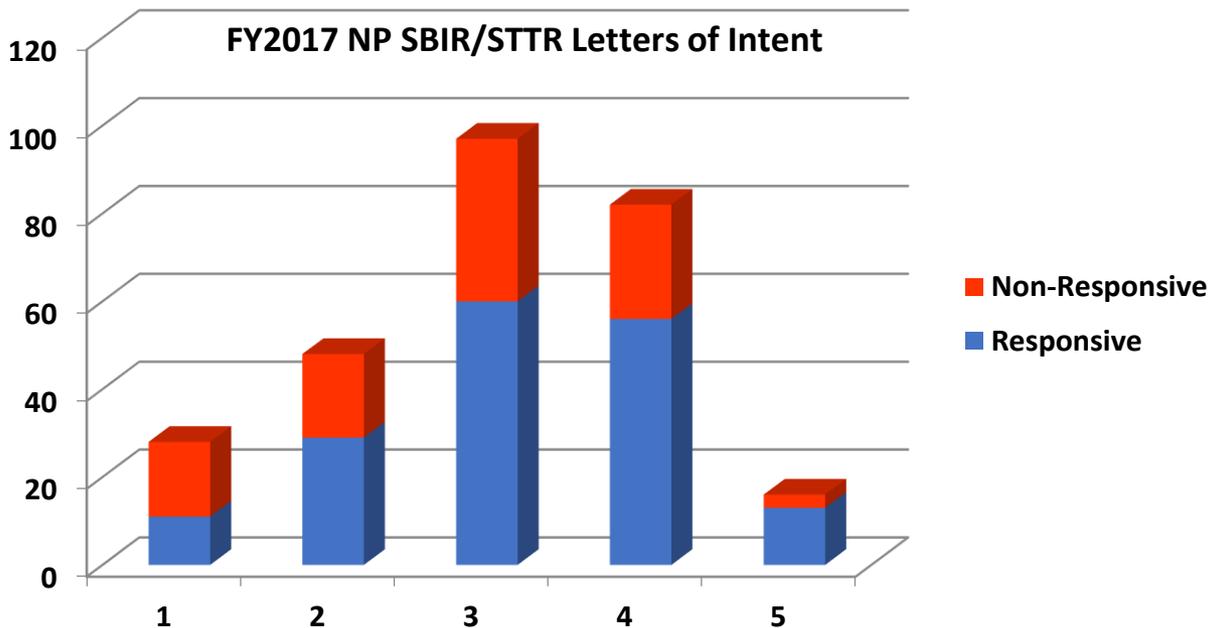
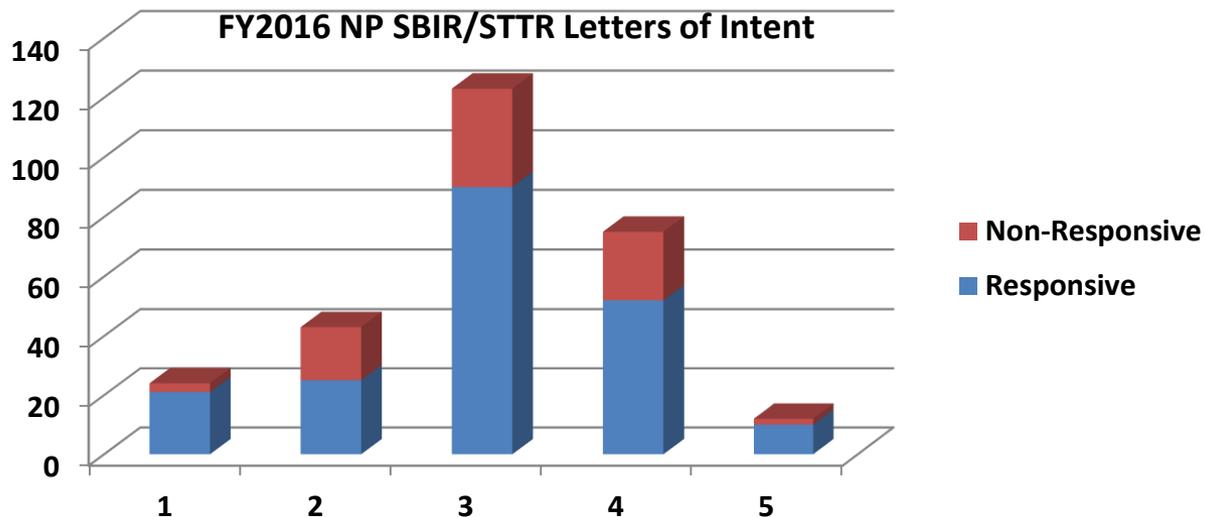
## NP Topic 5 Isotope Science and Technology

- a. Novel or Improved Production Techniques for Radioisotopes or Stable Isotopes
- b. Improved Radiochemical Separation Methods for Preparing High-Purity Radioisotopes
- c. Other

Topic Associate – Ethan Balkin

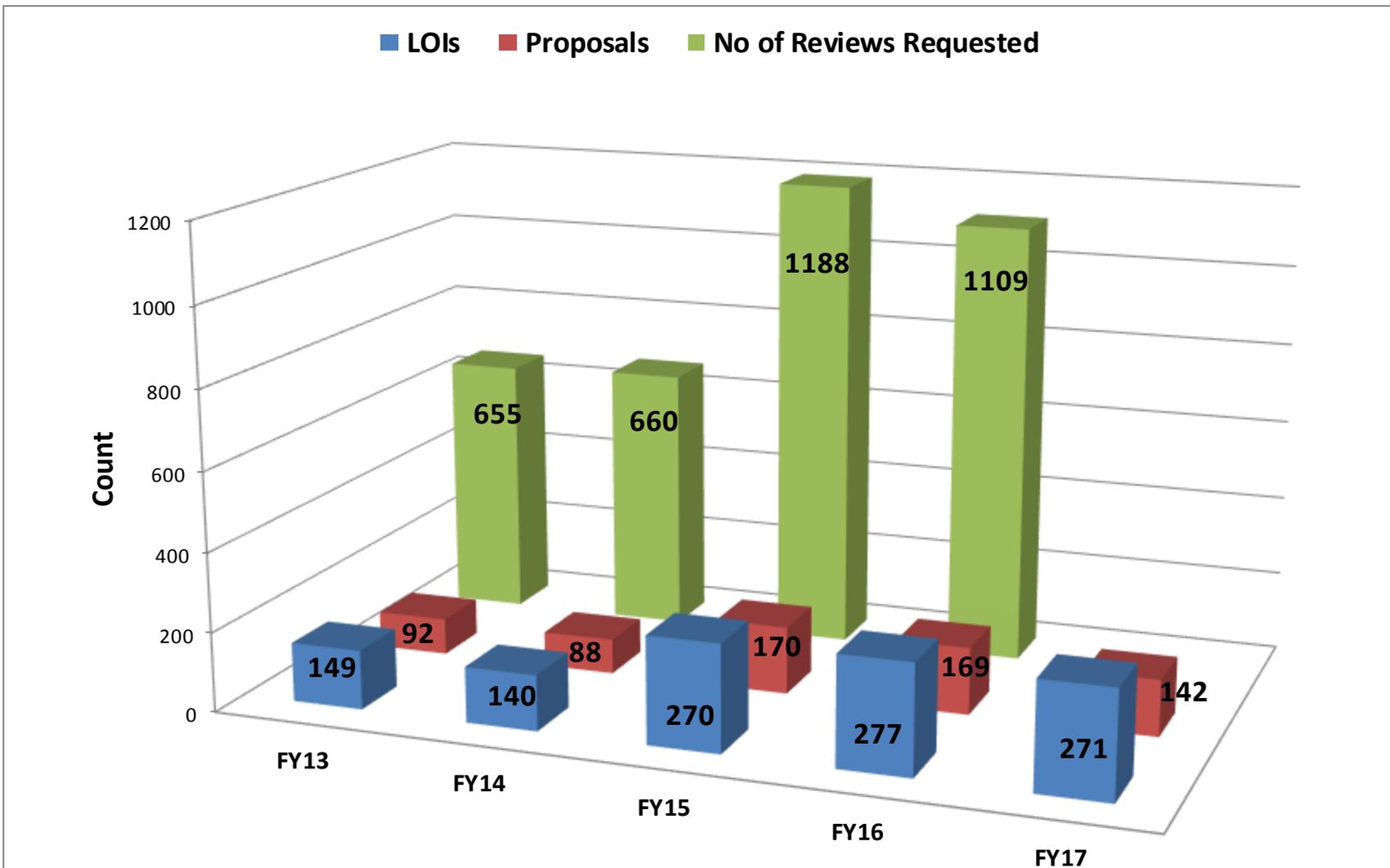


# NP Phase I SBIR/STTR LOIs FY 2016 v. 2017





# NP Phase I SBIR/STTR LOIs and Applications (FY2013 - 2017)



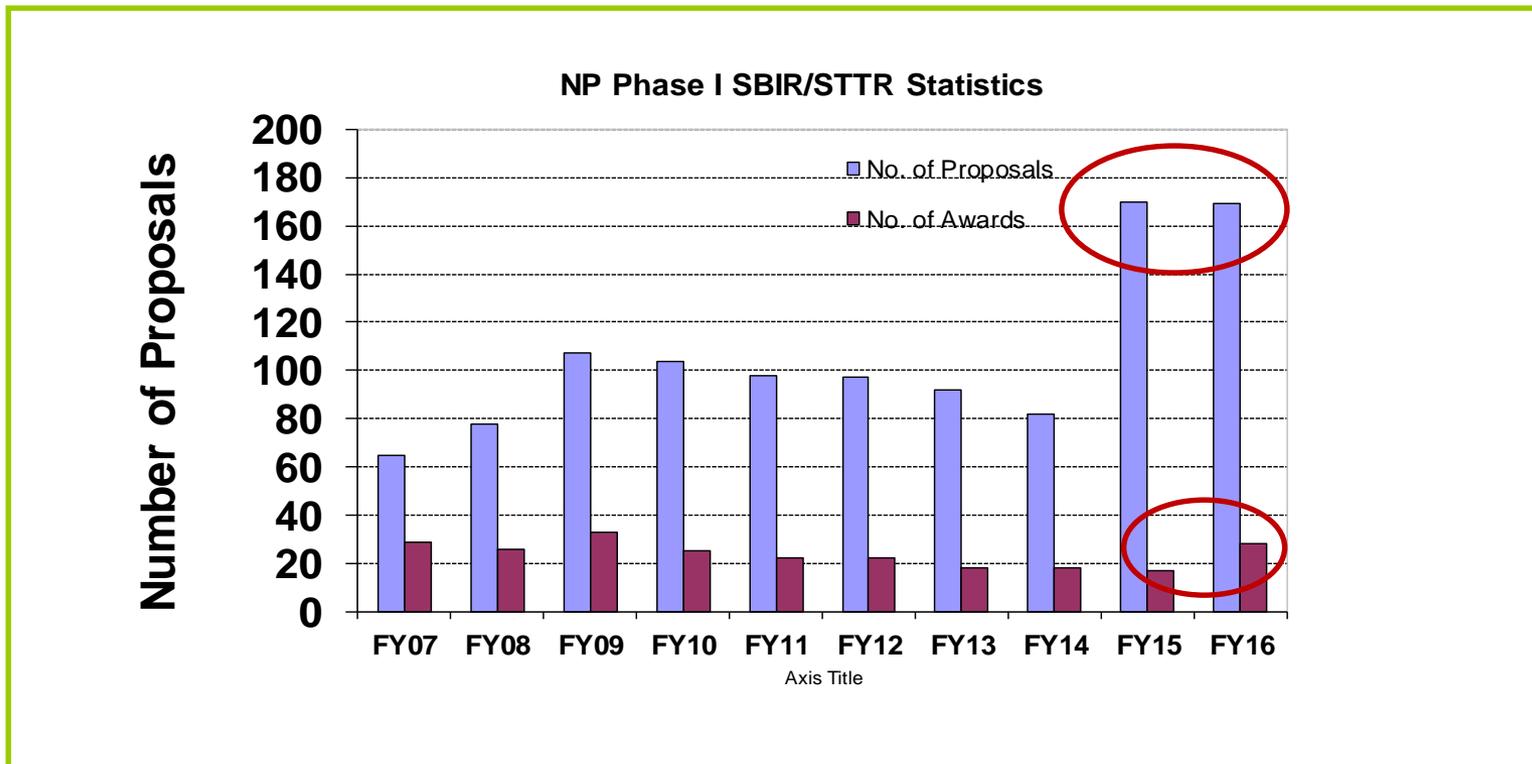
In FY15: HEP moved out of DOE Release 1's FOA

- The # of LOIs and proposals nearly doubled since then.



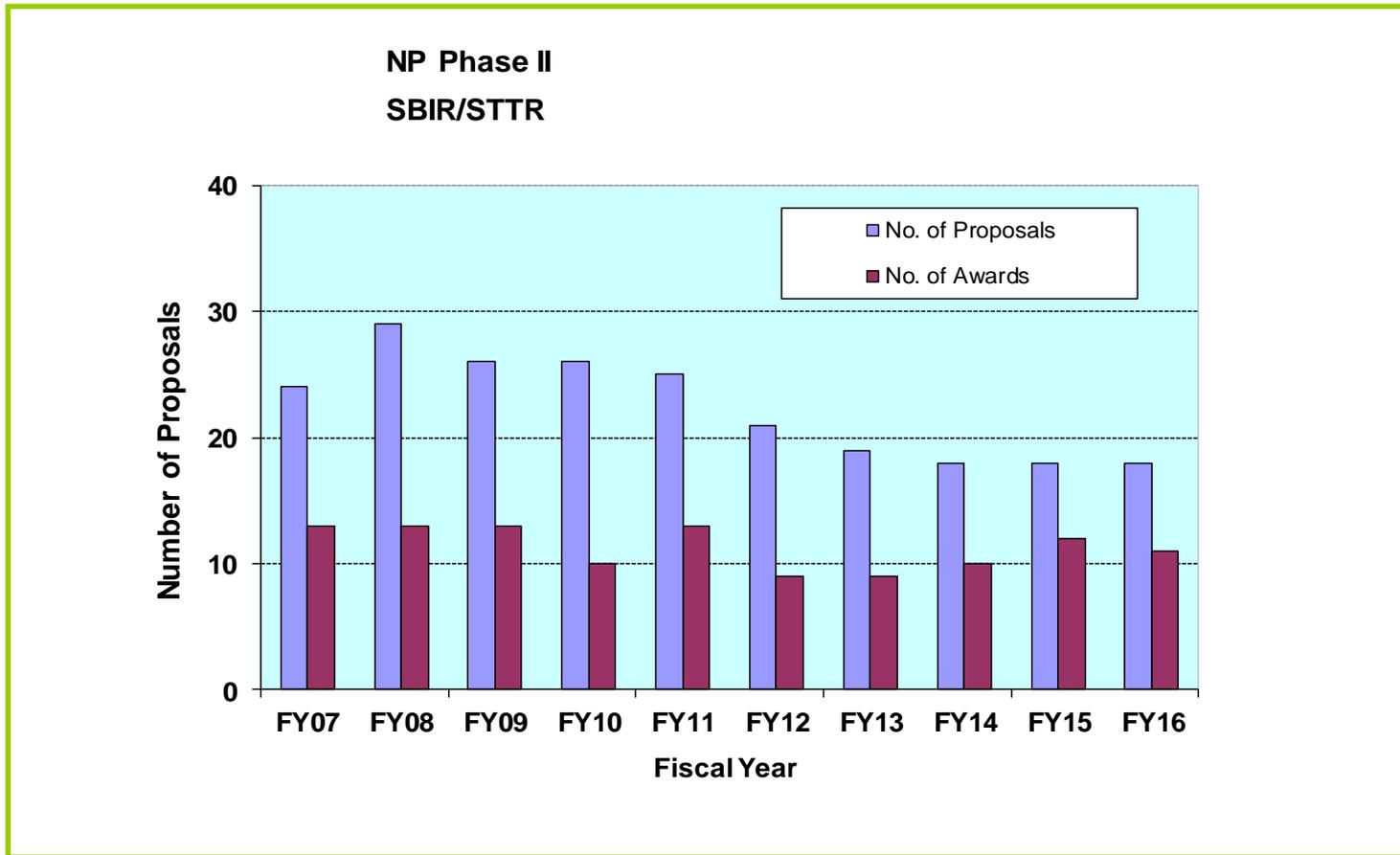
# NP Phase I SBIR/STTR Applications and Awards

- NP received a Total of **277** LOI and **169** phase I proposals in FY 2016, with **1109** review requests for a total of **~ 423** mail reviews. Total of **28** proposals funded. (cf 18 in FY15)
- There was a huge increase of applications since FY15. It now requires a dedicated Program Manager, assistance from a Portfolio Manager as well as from the Topic Associates (Program Managers for the Software, Instrumentation, and Isotopes Topics).





# NP Phase II SBIR/STTR Applications and Awards



The increase in maximum SBIR award amounts starting in FY 2011 (from \$750K to \$1M) has affected the number of Phase II awards that can be supported.



# The NP SBIR/STTR Exchange Meeting is Unique in the Office of Science

- Initiated by Manouchehr Farkondeh
- NP seeks to effectively assess the performance of NP supported SBIR/STTR projects in contributing to the NP mission and goals. Started in FY2010, the Exchange Meeting is designed to serve that purpose as well as:
  - To **provide a platform** for small businesses to present the status of NP-supported Phase II grant work to the NP community and Federal Program Managers
  - To offer an opportunity to **exchange information** regarding the **companies' capabilities** and the technical needs of the NP programs
  - To **strengthen the ties** of the SBIR/STTR businesses **with the community** and enhance the possibilities for commercialization
- Typically, 60-80 participants attend the two day meeting

# NP SBIR/STTR Program Successes

- Over the last 10 years the SBIR/STTR program funding has fueled innovation that:
- Has led to advances that benefit the NP facilities and community
- Has resulted in commercial products with uses outside of nuclear science

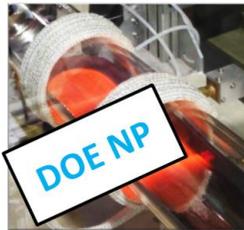
## 2010 – Improved Gamma/Neutron detectors

- Radiation Monitoring Devices developed  $\text{Cs}_2\text{LiYCl}_6:\text{Ce}$  (CLYC)
  - Usually  $^6\text{Li}$  enriched to 95%, if enriched in  $^7\text{Li}$ , it suppresses thermal neutron detection
  - NP SBIR-funded as a high resolution scintillator for instrumentation – considered as a replacement for other, more traditional scintillators
  - Funded by other agencies, e.g. DNDO/DTRA/NNSA for personnel radiation monitors
  - Now a commercial product

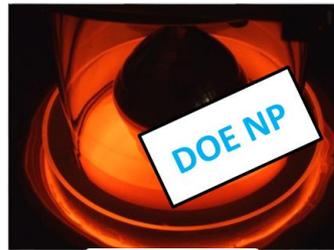


# 2014 – Large segmented Ge crystals and electronics for Hi-Res $\gamma$ -ray spectroscopy

- PHDS Co leveraged NP SBIR grants to grow high purity Ge crystals
  - Developed a self-contained imaging system - Germanium Gamma Ray Imager (GeGI)
  - Now used commercially for nuclear materials identification



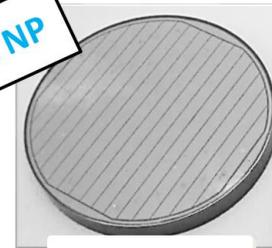
Zone Refine



Growth



Analysis



Fabrication



Commercial



Integration  
Electronics  
Imaging



Cryogenics



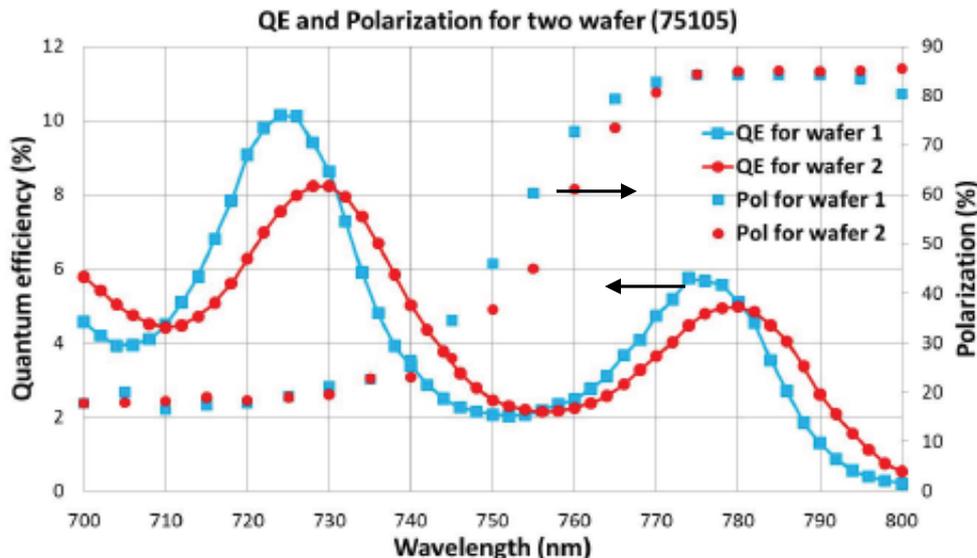
# 2016 – High quantum efficiency photocathodes to generate polarized electrons

- SVT Associates Inc. has optimized the growth of a Distributed Bragg Reflector (DBR) beneath a high polarization superlattice photocathode, with a measured quantum efficiency of ~ 5%
- Before this year, typical quantum efficiencies were in the range of 0.8%
- This will have a positive impact on the operation of CEBAF, as well as a future EIC

•Low growth temperature  
 •Very low growth rate for Al-containing layers

Previous best QE: 1.6 %

Important milestone:  
 Over 5% QE with 87% polarization for the first time!



2 pieces cut from a 3-inch wafer



## 2016 – HF-free electropolishing of SRF accelerator cavities

- Faraday Technology has optimized their process for electropolishing superconducting RF (SRF) niobium cavities without the use of HF acid.
  - This reduces cost associated with the storage, use, and disposal of that particular acid.
  - Multi-Lab (JLAB-FNAL-ORNL) and industry (AES) participation.
    - R&D 100 Award Finalist
- Being deployed at ORNL for processing of SNS SRF cavities.

### Pulse Reverse EP Studies

- Vertical (electrolyte “dump” mode)
- 100% Volume Fill
- No Rotation
- 5-10 wt.%  $H_2SO_4$  in  $H_2O$

➔ Simpler

➔ Industrial Compatible



# 2016 – Holographic storage densities > 2Tb/in<sup>2</sup>

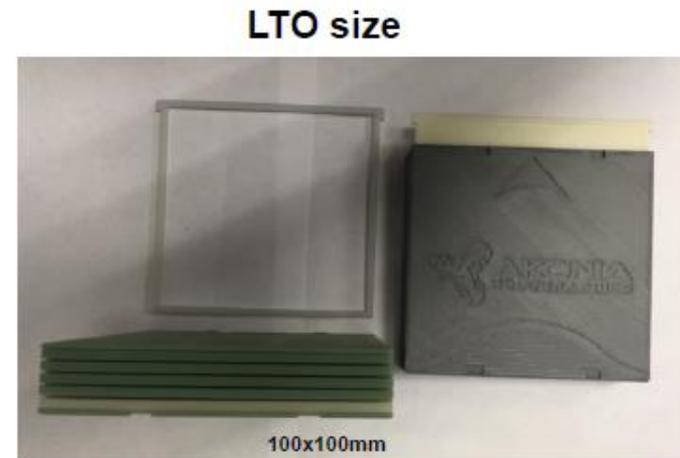
- In FY14 Akonia Holographics received a Fast Track Award for their proposal “Low-Latency Ultra-High Capacity Holographic Data Storage Archive Library”
- In Dec. 2015, Akonia Holographics achieved a world record areal storage density of 2.2Tb/in<sup>2</sup>.

- ✓ <\$1/TB Media Cost by 2020
- ✓ 5x Better Cost/TB (System)
- ✓ 10x Better Total Cost of Ownership
- ✓ 30x Latency Improvement (time to first data)
- ✓ 11x Energy Savings
- ✓ 2x-4x Better Footprint (high density)



## Holographic Storage Wins: Cost, Footprint, Speed, and Reliability

\*Note: Comparisons are made using best estimated future projections in 2020.





# NP SBIR/STTR Program Changes in FY17

- We wish to better connect businesses to the NP community
- To do this, we are adding an NP-specific “Awards” page to the existing SBIR/STTR webpage
  - This page will list the awardee, contact info, the abstract, etc. for the current year and the previous two years
- We have an email list you can join: [NP-SBIR-STTR@science.doe.gov](mailto:NP-SBIR-STTR@science.doe.gov)
  - You will receive only a few emails a year,
    - Announcement of SBIR/STTR Calendar
    - Announcement and link that SBIR/STTR Topics are available
    - Announcement of grants
- The SBIR Office is implementing a Phase I Principal Investigator Meeting, to be held in June each year. The objectives are-
  - In person meetings with DOE program managers and DOE Commercialization Assistance providers
  - Presentations relating to Phase II and Commercialization
  - Small business networking



# Conclusions

- NP uses the Congressionally-mandated SBIR/STTR Program –
  - To fund R&D that benefits the NP community
  - To build and sustain a US-based commercial infrastructure that serves society in areas other than nuclear science
- Three years of funding is equivalent to that of a large research effort
  - With input from Program Managers and the community, the NP SBIR/STTR program uses those funds for R&D that advances our core technologies as well as new initiatives
- NP uniquely fosters the connection between the NP community and the small businesses that serve it through an annual meeting
  - This in turn enhances opportunities for commercialization